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TECHNICAL NOTE

A DEVICE FOR CHRONICALLY CONTROLLED VISUAL INPUT[1]

While many studies with visual stimuli have been carried out, experimenters have merely provided objects to look at without any direct control over the locus and area of visual stimulation. With recent advances in optical technology (Kapany, 1967), direct control of visual input to the animal's eyes appears both feasible and useful. Two types of experiments suggest themselves. Firstly, with the demonstrated utility of a device which brings visual stimuli directly to the eye, studies may be conducted on animals which would be unable to turn away from or "avoid" a visual display when presented. The device described below differs from previous models (Zattoni, 1968) which require considerable surgical and pharmacological preparations and are limited in use to 15 days.

Adult domestic pigeons were equipped with a fiber optical unit consisting of a cylindrical aluminum goggle (5/8-in. outside diameter, 1/16-in. wall, 1 1/2 in. long) attached to the pigeon's head by means of standard dental cement. Figure 1 shows the basic goggle unit with the addition of a 10X magnifying lens used in another application discussed later. The goggles were angled along the bird's head so as to be almost parallel to the beak. This positioning allowed the bird's head to enter a standard food magazine without difficulty. The end of the goggle was capped with black Plexiglas. A 0.087-in. diameter plastic fiber optic light guide (E.I. Dupont DeNemours & Co.) was fitted through a hole in the black Plexiglas and cemented into place with Epoxy cement. The ends of the light guide had previously been ground, polished, and capped (an inexpensive grinding kit is available from Edmund Scientific Co., Barrington, New Jersey 08007). The fiber light guide was then bent around the goggle and cemented into place with Epoxy. If glass light guides are used (American Optical Co., Southbridge, Mass. 01550), care must be taken not to exceed their specified minimum radius of bend at this point in the procedure. In general, the plastic fibers have been found to be more flexible, more durable, and considerably less expensive than their glass counterparts. Six-foot lengths were used and the ends of the guides were brought out the top of the animal's box to a stand fixed to a Carousel projector located in an adjacent soundproof room. The unit can also be fixed to a digital display unit. Since the light guides are capable of transmitting from 310 to 1330 mμ, the Carousel projector can be provided with any number of filters to send varied visual stimuli, thus increasing the range available with digital display units. The projectors and programming equipment can be located at any distance from the animal as long as fibers of adequate length are used. However, approximately 1% of the light entering the fiber is lost per foot of transmission. Its flexibility and extremely light weight enable the animal to wear the unit chronically with all connections and with a minimum of restraint. Approximately 5 in. of light guide slack in the animal's box will allow free turning.

To demonstrate the effectiveness of the unit, two adult pigeons were prepared with monocular goggles on their right eyes. The birds were then trained in a standard operant unit to peck at a single non-illuminated response key for 3-sec mixed-grain reinforcements on a multiple fixed ratio 50, extinction (*mult* FR 50 EXT) schedule. The response key could be observed by the animal's left eye while the right eye, equipped with a goggle, was provided with white light during the FR component and red light during the extinction component. Each component was in effect for 2 min and the order of presentation was randomized. In addition, "feedback clicks" for key pecks were provided to aid in response maintenance (*cf.* Catania, 1963). After four training sessions of 1 hr each, discrimination performance was perfect with no responses occurring to the red presentations. By the end of the tenth session, both birds were able to achieve an asymptotic rate of two responses per second to the white light (excluding

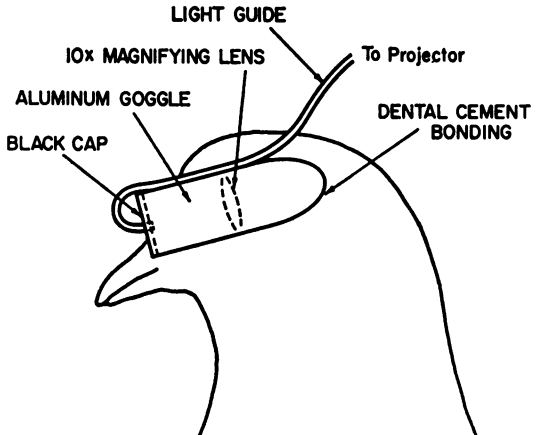

Fig. 1. Schematic showing placement of magnifying lens for image-conductant fiber bundles.

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pauses after reinforcement). However, pauses after reinforcement were common, lasting up to 30 sec. By the end of the twentieth session, the FR schedule had its final effect with only an occasional brief pause following reinforcement. Throughout the training the animals were able to move about, feed, and to peck at the key in a normal way.

For studies involving visual stimuli consisting of images, the use of image-transmitting "coherent" glass fiber bundles (American Optical Co.) is suggested. Although standard fiber bundles incorporated into commerically available fiberscopes contain all the necessary objective and ocular lenses for transmitting images from a projector to the goggles, they are heavy and add considerable restraint to the bird's movements. Alternatively, bare fiber bundles without lenses can be purchased at a considerable reduction in cost and weight and fitted with a simple magnifying lens in the goggle itself. A six-foot fiber bundle with a 3-mm diameter image format and a multifiber cross section of 60 microns is presently being used. The goggle contains a 10X magnifier cemented at its focal length of 1 in. from the end of the fiber bundle (see Fig. 1). This increases the 3-mm diameter image format to approximately 12 mm. While stimuli presented in this manner are probably not within the range of accommodation for the pigeon, a negative lens (—0.5 diopter) can be inserted in the goggle to aid in this correction. When using image-transmitting bundles, the goggles should be positioned at right angles to the bird's eye to avoid the large refractive error associated with light entering the cornea at acute angles. This placement of the goggles will necessitate widening the opening to the food magazine to accommodate the animal's head.

A second type of experiment is suggested by the utility of this device. Studies may be conducted on neonates which have their total visual stimulation controlled from the time they open their eyes. Such studies could be conducted in normal laboratory environments without special rearing facilities. Preliminary studies with rearing kittens equipped with these units have indicated that the goggles may be attached to a tight-fitting latex hood molded to the individual animal. Since this material will expand with growth processes, it need be changed only once every 30 days. However, due to the developmental changes in such functions as accommodation and fixation, the use of these goggles in rearing studies is presently limited to stimuli varying in intensity or wavelength.

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